SCRIPTA MEDICA (BRNO) – 74 (1): 39–44, *February 2001*

BAROREFLEX SENSITIVITY IN PATIENTS WITH CHRONIC CORONARY ARTERY DISEASE: INFLUENCE OF EIGHT WEEK'S EXERCISE TRAINING

JANČÍK J.[1], SVAČINOVÁ H.[1], SIEGELOVÁ J.[1], DOBŠÁK P.[1], PLACHETA Z.[1], FIŠER B.[1], DUŠEK J.[1], MELUZÍN J. [1], TOMAN J.[1], SAVIN E.[2], MARTINEAUD J.P.[2]

[1]Department of Functional Diagnostics and Rehabilitation, Faculty of Medicine, Masaryk University, Brno
[2] Hopital Lariboisiere, Paris, France

A b s t r a c t

Low baroreflex sensitivity (BRS) is a marker of increased risk of sudden cardiac death in patients after myocardial infarction. The present study was designed to evaluate whether a specific program of eight week's exercise training at anaerobic threshold level may be sufficient to improve BRS in patients with chronic coronary disease. Twenty patients with chronic coronary artery disease were selected on the basis of cardiographic, coronarographic and NYHA evaluation (I-II). Symptom-limited spiroergometry was carried out before and after the training. BRS was determined by spectral analysis of the pulse interval and systolic blood pressure. It is concluded that 8 weeks of exercise training at anaerobic threshold level was sufficient to improve BRS in patients with chronic coronary disease.

K e y w o r d s

Chronic heart disease, 8-week exercise training, Cardiopulmonary functions, Baroreflex sensitivity

INTRODUCTION

Sympathetic overactivity associated with low parasympathetic activity is an autonomic dysfunction which increases cardiac mortality *(1).* Heart rate variability and baroreflex sensitivity are the values which reflect the autonomic dysfunction *(2, 3, 4, 5).* In patients with essential hypertension, low heart rate variability and BRS are present, both being markers of increased sympathetic activity *(6, 7, 8, 9, 10, 11).* Low baroreflex sensitivity (BRS) is a marker for an increased risk of sudden cardiac death in patients after myocardial infarction *(12, 13).*The present study was designed to evaluate whether a specific programme of exercise training at an anaerobic threshold level may be sufficient to improve cardiopulmonary functions and BRS of patients with chronic coronary disease (CCD).

MATERIALS AND METHODS

Patients

Twenty patients (body weight, 86±6 kg; body height, 17±56cm; age, 63±8 years) with chronic coronary artery disease were selected according to the inclusion criteria listed below. Their diagnosis was established using single-photon emission computed tomography (SPECT), stress echocardiography (ECG record of ischaemia during exercise testing) and coronarography and on the basis of the NYHA classification (I-II). Medical regimens of all the selected patients were optimised to ensure that the patients were symptomatically stable Standardised medical treatment at the beginning and the end of the 8-week period included administration of angiotensin converting enzyme inhibitors, diuretics, nitrates and digitalis in varying combinations.

Criteria for inclusion: Presence of at least one coronary stenosis of more than 50% of the lumen diameter. Objective evidence of ischaemia (positive SPECT or positive ECG response during exercise testing). Patient's informed consent.

The study included patients who had undergone both cardiopulmonary exercise testing and echocardiography on two occasions separated by an interval of 8 weeks.

For assessment of autonomic function as a measure of baroreflex sensitivity (BRS) related to ageing, we included a group of healthy subjects (n=15) matched by sex, age, body weight and height (64±8 years; 84±6 kg; 173±7cm).

Experimental procedure

The symptom-limited spiroergometry was provided before and after the training. We evaluated the maximal attained workload Wmax, (W), peak oxygen consumption (VO2, $ml.min^{-1}$); peak VO2. kg^{-1} body weight; maximal consumption of oxygen expressed in metabolic units (MET).

Training period

Prior to the training course, spiroergometry was used to assess the anaerobic threshold for the determination of intensity of training in each individual. The training was provided in the Department of Functional Diagnostics and Rehabilitation three times a week and consisted of a 15-minute warm-up phase of individual exercises followed by 30 minutes of cycling, with the individual anaerobic threshold workload, and ending with the patients having a cool-down phase of 15 min.

Echocardiography

Echographic measurements of left ventricular function and the ejection fraction (EF) were carried out before and after the training period, using Hewlett-Packard, SONOS 2000 (USA) echocardiographic equipment.

Baroreflex sensitivity

BRS ($ms.mmHg^{-1}$) was determined by spectral analysis of the pulse interval (PI, ms) and systolic blood pressure (SBP, mmHg). The blood pressure was recorded for 5 min of beat-to-beat, non-invasive monitoring in the sitting position (Finapres Ohmeda [14]) during metronome-controlled breathing at a frequency of 0.3 Hz) before and after the training *(15).* In the control group, only one measurement of BRS was taken under resting conditions.

The study was approved by the Ethics Committee of Masaryk University in Brno and all subjects gave their written informed consent.

The results, expressed as mean±SD, were statistically evaluated with the use of ANOVA and Wilcoxon tests; P values < 0.05 were considered significant.

RESULTS

The results of PI, SBP, BRS W_{max}, peak VO_2 and MET values before (B) and after (A) the training are given in *Tables 1 and 2*. In the patients (P), there were significant differences in W_{max} values between the measurements at the beginning and the end of the 8-week period of training (*Table 1*). A significant increase in resting PI and in BRS values (P<0.05) was found in the patients at the end, as compared with the beginning of training. The PI values in the patients after training (PA) were almost the same as in the control group (C), while the BRS values did not achieve the levels of healthy subjects (C).

Our results show that, in the patients with coronary artery disease, eight weeks of exercise training at the anaerobic threshold level produced an increase in pulse interval, baroreflex sensitivity and in the maximal attained workload.

Table 1

The values of Wmax (W), peak VO2 ($ml.min^{-1}.kg^{-1}$) and MET in the patient group (P) before (B) and after (A) the training

	Wmax	VO2	MET
PB	142±31	20±4	6.2±1
PA	156±32 *	21±3	6.4±1

*, significant difference between PB and PA (P<0.05).

Table 2

The values of PI (ms), SBP (mmHg), DBP (mmHg) and BRS ($ms.mmHg^{-1}$) in the patient group (P) before (B) and after (A) the training and in the control group (C)

	PI	SBP	DBP	BRS
PB	852±163 +	123±19	66±12	2.9±0.9 +
PA	926±126 *	130±16	67±9	3.9±1.1*$^{\mathbf{x}}$
C	924±112	119±13	69±12	7.8±3.8

DBP, diastolic blood pressure; *****, significant differences in PI and BRS between PA and PB (P<0.05); **+**, significant differences between PB and C (P<0.05); **x,** significant difference between PA and C (P<0.05).

DISCUSSION

The assessment of baroreflex sensitivity was introduced to clinical practice by *Smyth, Sleight and Pickering* in 1969 (*cited by 7)*. These authors reported that intravenous administration of phenylephrin induces an increase in blood pressure and, as a reaction to it, there is a decrease in the heart rate. Baroreflex sensitivity is then expressed as an extension of the pulse interval (in ms) related to a rise in systolic blood pressure (per mmHg). Baroreflex heart rate sensitivity is low in patients with essential hypertension. This fact has been demonstrated by the classical phenylephrine method *(7)* and by a spectral method *(6, 8)*. The mean value of BRS in hypertensives is about one half of that in normotensives.

Impaired (decreased) baroreflex sensitivity is an indicator of increased risk of sudden cardiac death in patients after myocardial infarction. Myocardial infarction acutely reduces BRS that, however, may recover and return to normal values within 3 months *(16),* but not as a rule. Heart damage generally results in an increase in efferent sympathetic nervous activity. BRS is inversely related to potential ventricular fibrillation during experimental myocardial ischaemia *(17).* A low value of BRS is associated with increased mortality *(18).* There are other measures of cardiac damage, such as decreased heart rate variability, low ejection fraction, ventricular premature beats, blood pressure reduction, altered breathing patterns, elevated concentrations of cardiac enzyme and plasma norepinephrine, and a reduction in urine volume and urine sodium levels associated with a rise in plasma creatinine. In order to have any prognostic value, these criteria, which are more simple than BRS measuring, need coordination with BRS measurements. *Bigger et al. (18)* suggested that the relative utility of measurements of heart rate variability and of BRS for prediction of sudden cardiac death "needs to be evaluated in a large prospective study". The "ATRAMI" study has shown the way to a more precise determination of the best prognostic indices to guide therapy *(19).*

In view of the facts stated above, the possible increase in BRS following our 8-week training course is important in terms of prognosis for patients with chronic artery disease.

Jančík J., Svačinová H., Siegelová J., Dobšák P., Placheta Z., Fišer B., Dušek J., Meluzín J., Toman J., Savin E., Martineaud J.P.

BAROREFLEXNÍ SENZITIVITA U PACIENTŮ S CHRONICKÝM ONEMOCNĚNÍM KORONÁRNÍCH TEPEN: VLIV 8 -TÝDENNÍHO TRÉNINKU

S o u h r n

Nízká baroreflexní sensitivita (BRS) je znakem zvýšeného rizika výskytu náhlé srdeční smrti u pacientů s infarktem myokardu. Tato studie měla posoudit, zda specifický program 8-týdenního rehabilitačního tréninku na úrovni anerobního prahu může být dostatečný pro zlepšení BRS u pacientů s chronickou ischemickou chorobou srdeční. Vyšetřili jsme 20 nemocných s chronickou ischemickou chorobou srdeční (kardiografie, koronarografie, NYHA I-II, stabilní léčba, hmotnost

86±6 kg, věk 63±8 let). Symptomy limitovaná spiroergometrie byla provedena před tréninkem a po něm. BRS byla stanovena spektrální analýzou pulzového intervalu a systolického krevního tlaku. Z našich výsledků uzavíráme, že 8-týdenní rehabilitační trénink na úrovni anerobního prahu byl dostatečný pro zlepšení BRS u pacientů s chronickou ischemickou chorobou srdeční.

A c k n o w l e d g e m e n t s

This study was supported by a grant no. 4705–3 from the Grant Agency of the Ministry of Health and a grant, CEZ: J07/98:141100004, from the Ministry of Education of the Czech Republic.

REFERENCES

1. *Schwarz PJ.* The neural control of heart rate and risk stratification after myocardial infarction. Europ Heart J 1999;1(Suppl):H33-H43.
2. *Mancia G, Parati G, Pomidossi G et al.* Arterial baroreflexes and blood pressure and heart rate variabilities in human. Hypertension 1986;8:147–53.
3. *Wang SJ, McClain J, Zucker H.* Aldosteron reduced baroreceptor discharge in the dog. Hypertension Dallas 1992;19:270–77.
4. *Korner PI, West MJ, Shaw J,Uther JB.* „Steady state“ properties of the baroreceptor-heart rate reflex in essential hypertension in man. Clinical and Experimental Pharmacology and Physiology 1974;1:65–76.
5. *Mancia G.* Bjorn Folkow Award Lecture – The sympathetic nervous system in hypertension. J Hypertension 1997;15:1553–565.
6. *Siegelová J, Fišer B, Dušek J, AL-Kubati M.* Baroreflex-Senstivitytsmessung bei Patienten mit essentieler Hypertonie: Einfluss von Enalapril. Nieren und Hochdruckkrankheiten 1995;24:20–2.
7. *Gribbin B, Pickering EG, Sleight P, Peto R.* Effect of age and high blood pressure on baroreflex sensitivity in man. Circ Res 1971;29:424–31.
8. *Siegelová J, Fišer B, Dušek J.* Baroreflex heart rate sensitivity in essential hypertension: the effect of Isoptin SR 240 therapy. In: Varro V, de Chatel R, eds. 22nd Congress of the Internat. Society of Internal Medicine, Italy: International Proceeding, Division Monduzzi Editore, 1994:99–102.
9. *Grassi G, Cattaneo BM, Seravalle G, Lanfranchi A, Mancia G.* Baroreflex control of sympathetic nerve activity in essential and secondary hypertension. Hypertension 1998; 31:68–72.
10. *Grassi G, Seravalle G, Cattaneo BM et al.* Sympathetic activation and loss of reflex sympathetic control in mild congestive heart failure. Circulation 1995;92:3206–211.
11. *Grassi G.* Role of the sympathetic nervous system in human hypertension. J Hypertension 1998;16:1979–987.
12. *Semrád B, Fišer J, Honzíková N.* Aging and cardiac autonomic status. In: Malik M, ed. Clinical Guide to cardiac autonomic test. London: Kluwer Academic Publishers, 1998;285–300.
13. *Semrád B, Fišer B, Honzíková N.* Blood pressure control by baroreflex in patients after myocardial infarction. Scripta medica 1997;70:3–8.
14. *Peňáz J.* Photoelectric measurement of blood pressure, volume and flow in the finger. In: Digest 10th Int Conf Med Biol Eng, Dresden, 1973:104.
15. *Al-Kubati M, Fišer B, Siegelová J.* Baroreflex sensitivity during psychological stress. Physiol Res 1997;46:27–33.
16. *Schwartz PJ, Zaza A, Pala M, Locati E, Beria G.* Baroreflex sensitivity and its evoluation during the first year after myocardial infarction. J Am Coll Cardiol 1988;12:629–36.
17. *Billman GE, Schwartz PJ, Stone HL.* Baroreceptor reflex control of heart rate: a predictor of sudden cardiac death. Circulation 1982;66:874–80.
18. *Bigger JT, La Rovere MT, Steinman RC et al.* Comparison of baroreflex sensitivity and heart period variability after myocardial infacrtion. J Am Coll Cardiol 1989;14:1511–518.
19. *La Rovere MT, Bigger JT, Marcus FI, Mortara A, Schwartz PJ.* Baroreflex sensitivity and heart-rate variability in prediction of total cardiac mortality after myocardial infarction. Lancet 1998;351:478–484.